

We claim:

1. A dental matrix resin, comprising the mixture of:
  - (a) a dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane;
  - (b) a dioxirane; and
  - (c) an initiator capable of initiating cationic polymerization of said resin.
2. The resin of claim 1, wherein said initiator is a photoinitiator.
3. The resin of claim 2, wherein said photoinitiator is selected from the group consisting of (4-n-octyloxyphenyl)phenyliodonium hexafluoroantimonate, [4-(2-hydroxytetradecyloxyphenyl)]phenyliodonium hexafluoroantimonate, [4-1-methylethyl]phenyl(4-methylphenyl)iodonium tetrakis(pentafluorophenyl)borate(1-), and combinations thereof.
4. The resin of claim 1, wherein said dioxiranyl tetraoxaspiro[5.5]undecane is selected from the group consisting of 3,9-bis(cyclohex-3-enylmethyl)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(6-methylcyclohex-3-enyl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis(cyclohex-3-enylmethoxy)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-Bis[(7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[2-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis(cyclohex-3-enyloxymethyl)-1,5,7,11-tetraoxaspiro{5.5}undecane, 3,9-bis[7-oxabicyclo[4.1.0]hept-3-yl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(6-methylcyclohex-3-enyl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-

oxabicyclo[4.1.0]hept-3-yl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane,[16] 8,10,19,20-tetraoxatrispiro[5.2.2.5.2.2]henicosa-2,14-diene, 7,26-dioxatrispiro[bicyclo[4.1.0]heptane-3,5'-1,3-dioxane-2'2''-1,3-dioxane-5'',4'''-bicyclo[4.1.0]heptane], and combinations thereof.

5. The resin of claim 1, wherein said dioxirane is selected from the group consisting of diglycidyl ether bisphenol A, 3',4'-epoxycyclohexanemethyl-3,4-epoxycyclohexane carboxylate, bis(2,3-oxiranylcyclopentyl)ether, butanediol diglycidyl ether, bis(3,4-epoxycyclohexylmethyl) adipate, and combinations thereof.

6. The resin of claim 1, further comprising:  
a polyol.

7. The resin of claim 6, wherein said polyol is selected from the group consisting of poly(tetrahydrofuran), 2-oxepanone polymer with 2-ethyl-2-(hydroxymethyl)-1,3-propane diol, and combinations thereof.

8. The resin of claim 1, further comprising:  
a photosensitizer.

9. The resin of claim 8, wherein said photosensitizer is selected from the group consisting of camphorquinone, 2-chlorothioxanthen-9-one, and combinations thereof.

10. The resin of claim 1, further comprising:  
a reaction promoter.

11. The resin of claim 10, wherein said reaction promoter is selected from the group consisting of ethyl p-dimethylaminobenzoate, 4,4'-bis(diethylamino)benzophenone, and combinations thereof.

12. The resin of claim 1, wherein said resin comprises about 1-30 weight % of said dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane, about 70-99 weight % of said dioxirane, and about 0.1-10 weight % of said initiator.

13. A dental restorative material, comprising the mixture of:

- (a) a dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane;
- (b) a dioxirane;
- (c) an initiator capable of initiating cationic polymerization; and
- (d) a dental filler that does not substantially interfere with cationic polymerization.

14. A method of making a dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane, comprising:

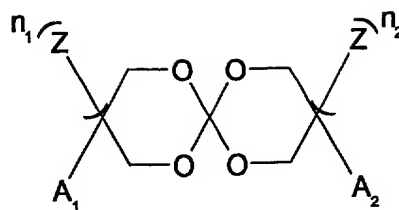
providing an alkyl substituted unsaturated cyclohexenyl group bonded to a propane diol by a flexible linkage selected from the group consisting of alkylene, oxyalkylene, and alkyleneoxy linkages;

subjecting said alkyl substituted cyclo to transesterification with a tetra-alkyl-orthocarbonate to obtain an unsaturated 1,5,7,11-tetraoxaspiro[5.5]undecane; and

epoxidizing said unsaturated 1,5,7,11-tetraoxaspiro[5.5]undecane with an organic per-acid to obtain a 1,5,7,11-dioxiranyl tetraoxaspiro[5.5]undecane.

15. The product of the method of claim 14.

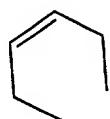
16. A compound of the structure:



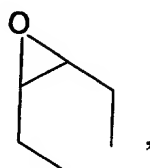
wherein,

$A_1$  and  $A_2$  are each a hydrogen, alkyl group, the completion of a cyclohexenyl group

or one of the following structures

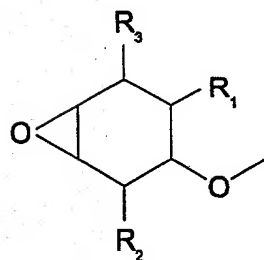
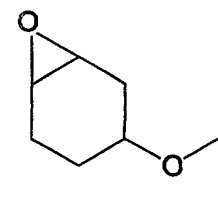
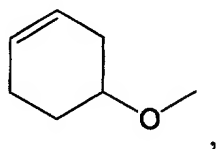
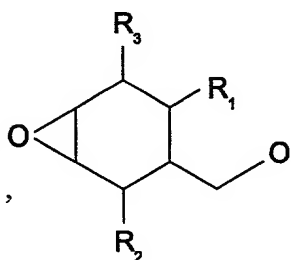
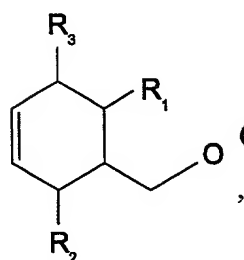
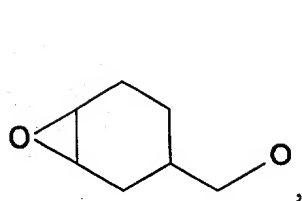
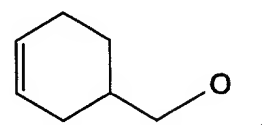
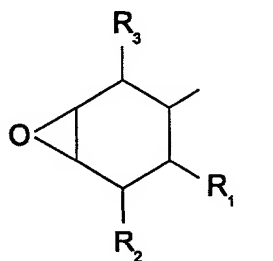
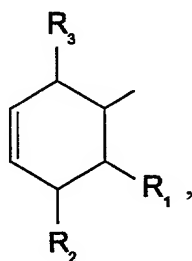
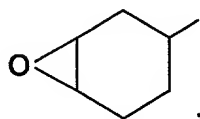
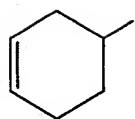


or

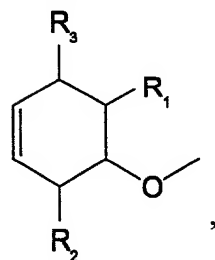


$n_1$  and  $n_2$  are each 0 or 1,

$Z$  is an alkyl group or is one of the following structures

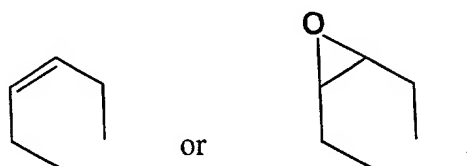


or

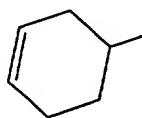


$R_1$ ,  $R_2$  and  $R_3$  are each a hydrogen or alkyl group; and

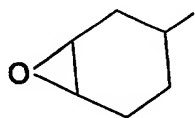
$A_1 = A_2$  and  $n_1 = n_2$ , with the proviso that if  $A_1$  and  $Z$  are both alkyl groups and  $n_1 = 1$ , then  $n_2 = 0$  and  $A_2$  is one of the following structures



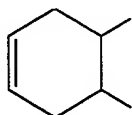
17. The compound of claim 16 wherein  $A_1$  and  $A_2 =$  hydrogen and  $n_1$  and  $n_2 = 1$  and  $Z$  is the following structure



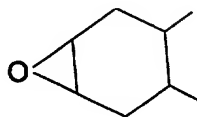
18. The compound of claim 16 wherein  $A_1$  and  $A_2 =$  hydrogen and  $n_1$  and  $n_2 = 1$  and  $Z$  is the following structure



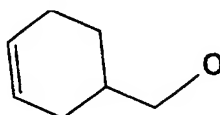
19. The compound of claim 16 wherein  $A_1$  and  $A_2 =$  hydrogen and  $n_1$  and  $n_2 = 1$  and  $Z$  is the following structure



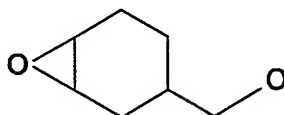
20. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



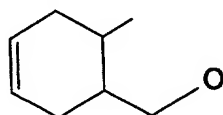
21. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



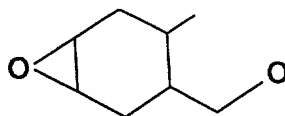
22. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



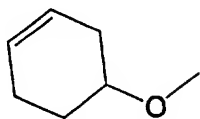
23. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



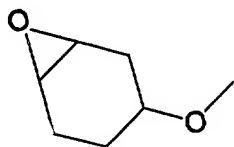
24. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



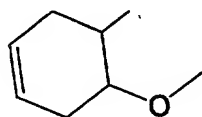
25. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



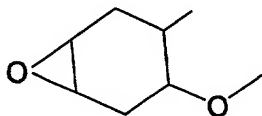
26. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



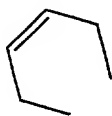
27. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



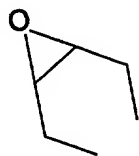
28. The compound of claim 16 wherein  $A_1$  and  $A_2$  = hydrogen and  $n_1$  and  $n_2$  = 1 and Z is the following structure



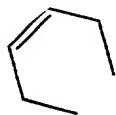
29. The compound of claim 16 wherein  $n_1$  and  $n_2$  = 0 and  $A_1$  and  $A_2$  are the following structure



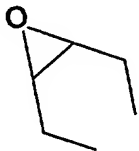
30. The compound of claim 16 wherein  $n_1$  and  $n_2 = 0$  and  $A_1$  and  $A_2$  are the following structure



31. The compound of claim 16 wherein  $n_1 = 1$ ,  $A_1$  and  $Z =$  ethyl groups,  $n_2 = 0$  and  $A_2$  is the following structure



32. The compound of claim 16 wherein  $n_1 = 1$ ,  $A_1$  and  $Z =$  ethyl groups,  $n_2 = 0$  and  $A_2$  is the following structure



33. The compound of claim 16 wherein  $R_2$  and  $R_3$  are each hydrogen and  $R_1$  is a lower alkyl group.

34. The compound of claim 16 wherein  $R_2$  and  $R_3$  are each hydrogen and  $R_1$  is a methyl group.

35. A dioxiranyl 1,5,7,11-tetraoxaspiro[5,5]undecane selected from the group consisting of 3,9-bis(cyclohex-3-enylmethyl)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(6-methylcyclohex-3-enyl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 8,10,19,20-tetraoxatrispiro[5.2.2.5.2.2]henicosa-2,14-diene, 7,26-dioxatrispiro[bicyclo[4.1.0]heptane-3,5'-1,3-dioxane-2'2''-1,3-dioxane-5'',4'''-



bicyclo[4.1.0]heptane], 3,9-bis(cyclohex-3-enylmethoxy)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[2-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis(cyclohex-3-enyloxymethyl)-1,5,7,11-tetraoxaspiro[5.5]undecane, and 3,9-bis[7-oxabicyclo[4.1.0]hept-3-yl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane.

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